

# Forging Partnerships With Industry

## BNL/NGC Case Study

Mike Anerella

November 16 – 18, 1998

## I) Partnership Structure

### BNL Responsibilities

- Provide proven design.
- Provide critical elements beyond capability of inexperienced industrial partner.
- Maintain ownership & control of magnet design, drawings.
- Transfer technology to industrial partner.
- Assist in solving problems.

## NGC Responsibilities

- Learn and understand magnet design.
- Tool design, assembly procedures (BNL approved).
- “Productionize” Magnet Design.
- Identify and solve problems.
- Maintain cost and schedule.
- Build magnets to BNL drawings and specifications.

## II) Contract Structure

- |                |                                  |      |
|----------------|----------------------------------|------|
| <u>Phase 1</u> | - Technology Transfer            |      |
|                | - Tooling Design and Manufacture | CPFF |
|                | - 30 Arc Dipole Magnets          |      |

CPFF = Cost Plus Fixed Fee;  
High risk to BNL, but allowed for greatest flexibility  
wrt Tech Transfer, Magnet Development  
ESSENTIAL TO PROGRAM SUCCESS

Phase 2 -268 arc dipole magnets > FPIF

FPIF = Fixing Price Incentive Firm;  
Begins with target price and target profit BNL/NGC  
shared additional costs/savings on 25%/75% ratio,  
up to a ceiling price after which NGC would have  
paid 100%

- provided incentive for both parties to control costs.

Phase 3 – 75 dipole magnets of (3) shorter lengths  
➤ FPIF

### III) Change Control

#### 1. Unplanned Changes

“Build-to-print”, but....

- improvements to design after contract award.
- cost saving measures suggested by NGC and sub-contractors.

ECR (Engineering Change Request) by BNL to NGC



submitted to NGC for review



ICP (Impact Change Proposal) as a result of  
proposed ECR submitted by NGC to BNL.



ICP reviewed at BNL



Cost negotiated w/NGC\*



ECR approved as ECN (Eng. Change Notice),  
Incorporated onto drawings and released to  
NGC.

- \* Sometimes due to schedule pressure postponed until after ECN approval, but an essential step nonetheless for control (~ 300 ECN's proposed cost = \$2.5M; negotiated cost = \$0.25M).

2. Planned Changes – listed explicitly in contract.

1. Coil cross-section change prior to fabrication of magnet #1.
2. Coil cross-section change prior to start of Phase 2\* (magnet #31).

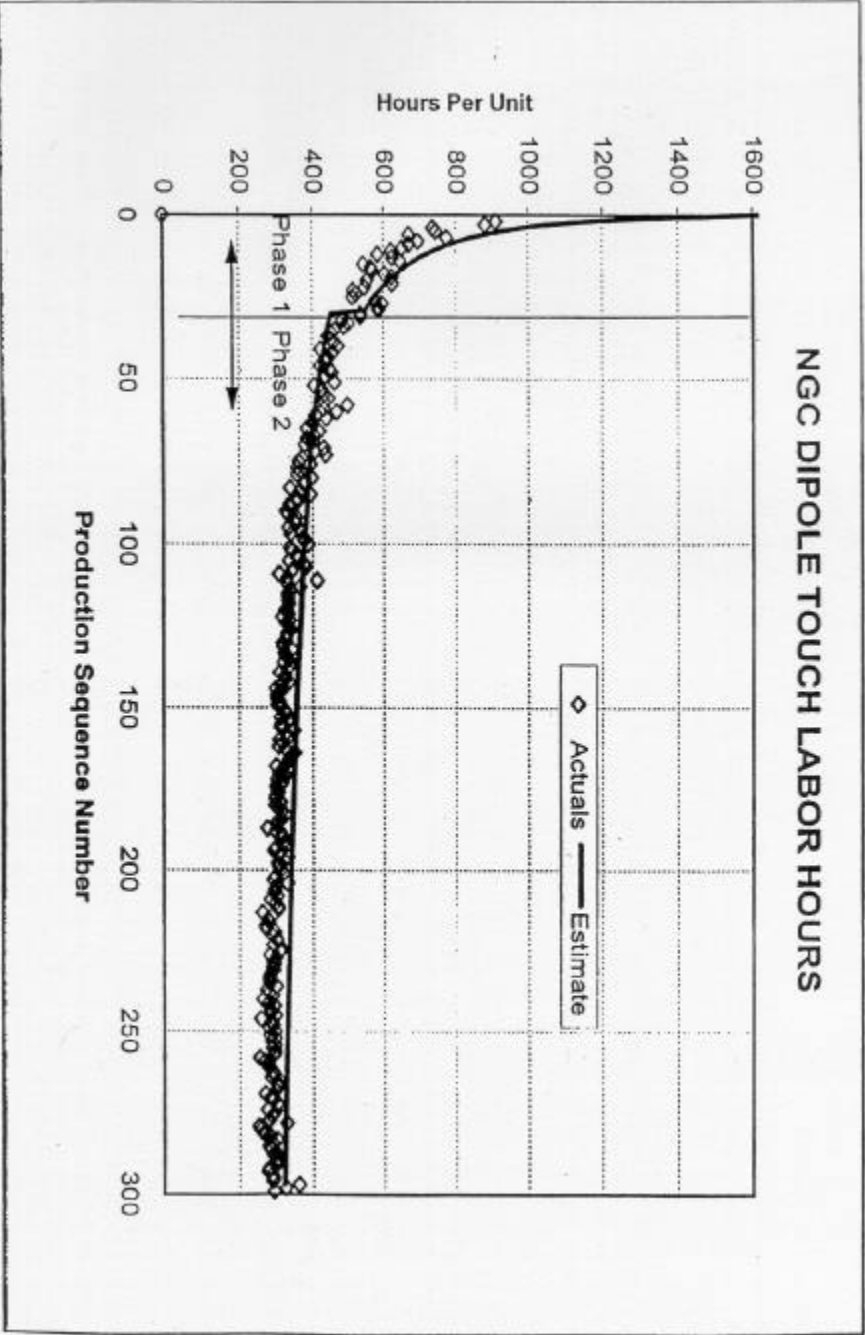
\*negotiated during contract:

- “Easy” interim change at magnet #20 (changed midplane cap, provided by BNL initially)
- Final cross-section (wedge) change delayed until magnet #106, when NGC could provide parts without schedule or cost impact.

#### IV) Performance

- Technology transfer was very successful, but ran \$13M (\$12M → \$25M) over budget and 8 months (17 months → 25 months) beyond schedule. Work was under-estimated by both partners; end product was perfect.
- Production was very successful
  - all magnets meet BNL specifications
  - all cold-tested magnets meet requirements with little training (performance allowed BNL to reduce cold testing to 10% in Phases 2 and 3)
  - Production labor costs were below budget, due to early learning by NGC in tech transfer, diligence in “producibility” issues in Phase 2 and 3 (see chart)
  - Magnets were completed on schedule (12/93 re-baseline – 5 months later than 7/92 original schedule)





- Contract Management was Less Successful
  - Program Manager did not blend well with partnership culture, resisted input from BNL, was eventually removed from contract.
  - QA was severely under-budgeted at contract inception, and was slow to respond to problems through most of contract, requiring constant BNL intervention. QA Manager was eventually removed from position by new Program Manager.
  - NGC was unprepared for the large number of change requests generated, and had to increase staff quickly to handle extra workload. Although costs were recovered, the effort drained attention from other areas of the program
  - Although production labor costs were well controlled, this represented only 8% of the cost of each magnet (see pie chart). Changes in overhead rates, by contrast, increased contract price by > \$2M.  
\$43M → \$ 58M

# Cost Components of Production Dipole Magnets

Cost per magnet = \$109,366

